Project Summary

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Modeling Capabilities of the Analytical Modeling Development Team

Issue: $Millions Have Been Saved by Analytical Modeling

Facts: The ERDC Geotechnical Lab (GL) has a track record of saving District money through advanced analysis. The GL Analytical Modeling Team is most successful when working hand-in-glove with Districts to provide timely answers to difficult issues. Pairing Corps research engineers with District engineers has proved a winning combination. Modeling tools used by the teams include in-house products such as STUBBS (FEM program), DDA (Discontinuous Deformation Analysis), Groundwater Modeling System (GMS), and commercially available tools like ABAQUS (©Hibbitt, Karlesson & Sorensen, Inc.). Teams have top quality testing equipment and access the WES centrifuge to provide experimental information to validate and support analytical work.

Documented Savings of More than $15 Million:

New Orleans District - $7.3 Million - NOD applied the FEM-based design to more than 115,900 ft of levee to save an average embedment depth of 5 ft. Also, a higher cost of special-run sheet pile was avoided.

Huntington District - $3.25 Million - A dike reinforced with wire-mesh was validated by modeling to be a feasible alternative to conventional staged construction on very soft ground. Previous attempts at staged construction had failed to provide sufficient height. The reinforced dike presented a small footprint, allowing construction on top of fill that had been place during the preceding 35 years. Conventional dike construction would have required purchasing ROW costing an estimated $3 Million.

Huntington District - $5 Million - A floodwall in a crowded urban area was required to play a dual role as retaining wall for unstable riverbanks. Cellular sheet-pile structures avoid the right-of-way problems associated with the conventional flat-based T-wall proposed to serve those two purposes. Traditionally, sheet pile cells are “tension” structures not intended for large lateral earth pressure. In addition, over half of each cell volume would contain the existing soft riverbank clay rather than the well-drained granular materials typically recommended for cell fill. The feasibility of the design was established when modeling demonstrated that the cells would be stable under the most adverse geologic and flood loading conditions anticipated for the site.

Galveston District - $455,000 - A barrier was constructed to check the advancement of erosion across the land barrier. Modeling verified those revetment blocks reinforced with geosynthetic could be used

to replace a proposed sheet pile wall to serve as the barrier along a portion of the channel underlain by very soft soils.

Recipe for an Effective Analysis:

The projects listed above have many common factors that made numerical analyses both necessary and successful.

Unprecedented Design – The source of large cost savings common to all examples listed is the application of new geotechnical construction methods or novel application of old techniques. In each case the District Engineers came up with the cost saving approach. The missing element supplied by the analysis was the assurance that the design would perform as expected. Much of traditional geotechnical analysis depends on empirical relationships. Proving out an unprecedented design is difficult and often implies expensive field trials. Realistic computer simulations can reduce uncertainties, make field observations more effective, and bring new design concepts into mainstream acceptance much sooner.

Non-Standard Analysis – Another key feature of the successful analytical project is the innovative nature of the analysis. Features of an analysis that quickly take it beyond the scope of traditional design manuals include:

- Complex interactions between structural elements and soil, particularly where stability is an issue
- Uncertain effects of construction sequence
- Uncertain effects of pore water pressure generation and dissipation on stability
- Critical role of dynamic forces in stability
- Any problem where deformations are an issue

However, the scope of the "traditional" design analysis is changing fast. Accessibility to tools for complex geotechnical analyses has increased greatly in the past decade. Problems once restricted to large mainframe computers can now run on Windows-based PCs. Improvements in hardware and software along with changes in engineering curricula are rapidly increasing the options for the District design engineer who is faced with a difficult design. Techniques once reserved for a numerical specialist are now available to District engineers and their contractors. Yet, many of the features listed above are still beyond the capabilities of PC-based analysis and require the abilities of the numerical specialists. It is up to the engineer to determine where the problem lies within the spectrum of technical difficulty. The Analytical Team can aid in determining the appropriate tool for a particular application.

Team Effort – Successful *application* of numerical analysis is a team effort. Geotechnical problems are solved through the concerted efforts of engineering geologists, laboratory specialists, geotechnical and structural design specialists, and construction specialist. Mature judgment based on common sense and experience is the key to a successful project. The numerical analyst must have an accurate understanding of the site characterization, the intent of the design, and the construction operation. Equally important, the engineer must understand the extent to which the analytical solution depends on information from each specialty.

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